

THE GENUS *ATHYRIUM* ROTH IN NAINITAL HILLS¹

K. K. DHIR² AND K. RANI

(With ten text-figures)

The paper deals with an illustrated taxonomic account of ten species of the genus *Athyrium* Roth from Nainital hills (North-Western Himalayas). From the detailed morphological observations, it is concluded that caudex coupled with indusial and spore ornamentation are found to be constant and decisive characters to classify the species. Half the number of species have distinctly perisporiate spores whereas the other half falls into the category of having non-perisporiate spores.

The Himalayan species of *Athyrium* Roth, the type genus of family Athyriaceae, have been variously treated by earlier workers. Clarke (1880) and Hope (1899, 1903) considered *Athyrium* as a subgenus of *Asplenium* Linn. Beddome (1883) kept *Athyrium* separate from *Asplenium* but he could not properly analyse the species complexes and their nomenclature. Bir & Shukla (1966) described 16 members of this rather difficult genus from Simla hills. Recently Dhir & Datta (1976) gave an explicit taxonomic account of *Athyrium* Roth from Dharamsala hills. In the present paper, which is a part of the project on 'Taxonomic revision of Himalayan Ferns', 10 members of the genus from Nainital hills are described and illustrated along with the key

for identification in the field. Voucher specimens are deposited in PAN.

Athyrium Roth

Rhizome short, erect or decumbent or elongate-creeping, scaly; Rachis glabrescent or sparsely scaly, grooved; lamina pinnately decompound, sometimes simply pinnate; texture herbaceous to coriaceous, glabrous except on the axes; venation anadromous, veins always free; sori dorsal, typically elongate, sometimes short and roundish; indusium of the same shape with entire or lacerate-fimbriate margins.

A large genus comprised of nearly 200 species with world wide distribution. 10 species occur in the area investigated.

KEY TO THE SPECIES

- A. fronds pinnate.
- B. Rhizome ascending; fronds caespitose; lamina small to medium sized.
- C. Rhizome scales dull-brown in colour.
- D. Lamina lanceolate, not attenuated downwards; spores perisporiate.
- E. Stipe brown, thin and fragile; sporangium non-glandular; indusium with acutely lobed margin *A. anisopterum*
- E. Stipe straw coloured, firm and erect; sporangium stalk with a gland; indusium with a wavy margin *A. rupicola*

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² Department of Botany, Panjab University, Chandigarh.

- D. Lamina linear-lanceolate, attenuated downwards; spores non-perisporiate *A. attenuatum*
- C. Rhizome scales golden or bright brown in colour
 - D. Lamina linear-lanceolate, narrowed at both ends, hairy; indusium lacerate *A. falcatum*
 - D. Lamina oblong-lanceolate, never attenuated at base, glabrous; indusium small, fugaceous *A. drepanopterum*
- B. Rhizome wide-creeping; fronds distant; lamina large, broadly-lanceolate; rachis and rachilets covered with multicellular uniseriate hairs; indusium with wavy margin; spores tuberculated *A. japonicum*
- A. Fronds bipinnate to decomponently-pinnate.
 - B. Rhizome ascending; fronds approximate, spores non-perisporiate.
 - C. Costae and costules setiferous; lamina broadly lanceolate, rooting by vegetative buds *A. clarkei*
 - C. Costae and costules not setiferous; lamina lanceolate, acuminate; stipe dark brown at base *A. proliferum*
 - B. Rhizome wide-creeping; oblong lanceolate to sub-deltoid lamina; spores perisporiate
 - C. Fronds bipinnate; stipe dark brown at base; secondary rachis glabrous; indusium with irregularly lobed margin *A. schimperii*
 - C. Fronds 3-4 pinnate; stipe stramineous, secondary rachis pubescent and spiny; sori minute; indusium with a wavy margin *A. pectinatum*

A. anisopterum Christ, Bull. Herb. Boiss. 6, 962, 1898.

Rhizome 0.5-0.7 cm thick, ascending, thickly covered at the apex with brown, lanceolate, 6.5-7 mm long, 0.6-1 mm broad at base scales; fronds closely tufted; stipes upto 6-7 cm long, fragile, brown, scaly at base, scales filiform, about 2 mm long and 0.2-0.3 mm broad at base with almost entire margin; lamina 10-14 × 1.5-2.5 cm, lanceolate, membranaceous, bipinnatifid; pinnae upto 13-14 jugate, broadly lanceolate, shortly stalked, cut down 1/3 to 2/3 distance to mid rib into distinct segments with crenate margin, basal lobe enlarged forming an auricle on the anterior side; texture rather flaccid, pinnatifid; venation pinnate, each vein 1-2 times forked; sori curved, generally on superior veinlets, indusiate; indusium stalked, reniform, membranaceous with acutely lobed margin; sporangia with 14-15 annulus cells; spores dark brown, globose, perisporiate (Fig. 1).

It grows on shaded and humus rich rocks

in the dense forests near Kilberi and Pangote (1,500-2,000 m). Very common in the area investigated.

A. rupicola (Hope) C. Chr., Ind. Fil., 145, 1905.

Rhizome upto 0.3-1 cm thick, ascending, covered with a tuft of scales; scales 6-7 mm long, 1-1.5 mm broad at base, dull brown, linear lanceolate, hair pointed and uniseriate; fronds tufted, 24-36 cm, dull green; stipes 7-12 cm long, firm, erect, straw coloured, clothed near the base with similar to rhizome but deciduous scales; lamina 17-24 × 6-9 cm, lanceolate, bipinnatifid; pinnae 18-25 jugate except for the acuminate apex, alternate, subsessile, 3-4.5 cm × 0.8-1.2 cm, narrow, lanceolate, acuminate at apex, cut down into 6-14 pairs of 4-5 mm × 1-3 mm pinnules with crenate or serrate margin, lower 1-2 pair deflexed; texture sub-coriaceous; veins pinnate, generally forked, one veinlet to each tooth, rachilets wavy; sori median, generally along the superior veinlets, linear or globose, indu-



Fig. 1. *Athyrium anisopterum*. a. Plant. A. Pinna showing venation, $\times 4.6$; B. Rhizome scale, $\times 21.8$; C. Stipe scale, $\times 21.8$; D. Indusium, $\times 21.8$; E. Sporangium, $\times 97.9$; F. Spores, $\times 282.8$.

Fig. 2. *Athyrium rupicola*. a. Plant. A. Pinna showing venation, $\times 3.8$; B. Rhizome scale, $\times 8.4$; C. Indusium, $\times 17.8$; D. Indusial cells, $\times 74.2$; E. Sporangium, $\times 74.2$; F. Spores, $\times 231.7$.

siate; indusium thin, membranaceous, glabrous, margin wavy with a few projections; sporangia with 19 celled annulus, glandular, glands stalked and attached near the base of the sporangial stalk; spores perisporiate with broad folded perisporium (Fig. 2).

It is always found growing in exposed places. Enroute Cheena Peak (2,600 m).

A. attenuatum (Clarke) Tagawa, Acta Phytotax. et Geobot., 16, 177, 1956.

Rhizome 1-1.5 cm thick, erect, densely covered with scales; scales brown, lanceolate, subulate, 5-6 mm long, about 1 mm broad at base; fronds 30-35 cm long, closely caespitose; stipes 2-6 cm long, firm, erect, grooved, scaly below; scales 3-5 mm long, similar to rhizome scales, lamina 25-32 \times 3.5-7.4 cm, linear-lanceolate, bipinnatifid; pinnae 25-29 pairs, patent or slightly ascending, pinnae gradually reduced, cut down into small closely placed segments with serrate margin; texture herbaceous, greenish-brown; venation simple or once forked; mid vein wavy; sori small acroscopic, indusiate; indusium reniform with irregular projections along the margin; sporangia with 16-17 annulus cells; spores light-yellow in colour, non-perisporiate, bilateral with smooth exine (Fig. 3).

Met with near Land's end as a lithophyte in rock-crevices.

A. falcatum Bedd., Ferns South India, t. 151, 1863.

Rhizome 2-6 mm thick, short, ascending, profusely branched, scaly; scales linear-lanceolate with long drawn out apical part, wavy margined, 8-9 mm long and 0.5-0.8 mm broad at base; fronds rather approximate; stipes 2.5-6 cm long, firm, erect with a well developed basal part, scaly; scales golden, linear-lanceolate, hair pointed uniseriate, margin smooth, 8-9 mm long and 0.5-0.9 mm broad at base; lamina 10.5-35 \times 2.5-5 cm, linear-

lanceolate, narrowed at both ends, bipinnatifid, primary rachis covered with similar to rhizome but smaller scales; pinnae 20-28 jugate, alternate, subsessile, lowest 2-3 pairs deflexed; pinnae falcate, generally furnished with a large obtuse auricle at both the superior and inferior base, cut down into 8-10 pairs of 1-3.2 \times 4-8 cm pinnules with crenated margin and obtuse apex; texture herbaceous, hairy along the veinlets, hairs 3-4 celled, thin walled; venation simple or sometimes forked; sori linear along the veinlets opening towards the mid-rib, indusiate; indusium more long than broad having finger-like lacerae along the margin; sporangia with 15-celled annulus; spores non-perisporiate, tuberculate (Fig. 4).

Grows on moist, exposed rocks. Commonly met with near Bhowali (1,500 m) and Sat-tal (1,200 m).

A. drepanopterum (Kze.) A. Br., Milde, Fil. Eur. 49, 1867.

Caudex stout, 3-5 cm in diameter, ascending, clothed with numerous reddish-brown, linear-lanceolate, hair uniseriate pointed, smooth margined having clear luminae with a few distorted cells, 6.7-10 mm long and 0.7-1 mm broad at base scales; fronds caespitose; stipe 8-15 cm long, grooved, dull straw-coloured, scaly at base, scales persistent, similar to rhizome scales; lamina 18-22 \times 2-4 cm, oblong-lanceolate, 1-2 pinnate; pinnae 28-32 jugate, often falcate, subsessile, alternate, 2-3 cm \times 4-6 mm, deeply pinnatifid into 8-11 segments; pinnules 2-3 \times 1-2 mm, ovate-lanceolate, auricled with serrate margin; texture coriaceous; venation simple, veins pinnated, almost reaching the margin; sori small, linear or curved in two rows one on either side of the mid rib, median, indusiate; indusium often hippocrepiform, brown, fugacious, membranaceous; sporangia with 14-15 celled annulus,

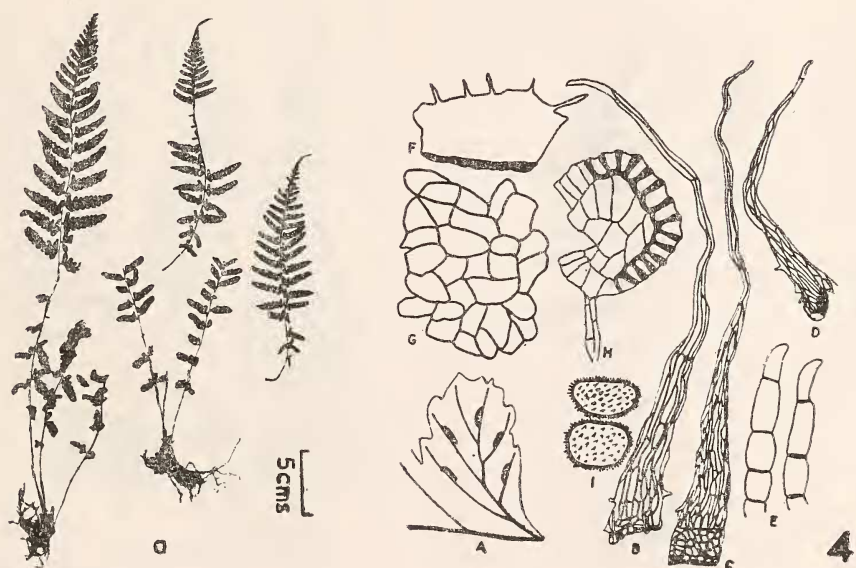
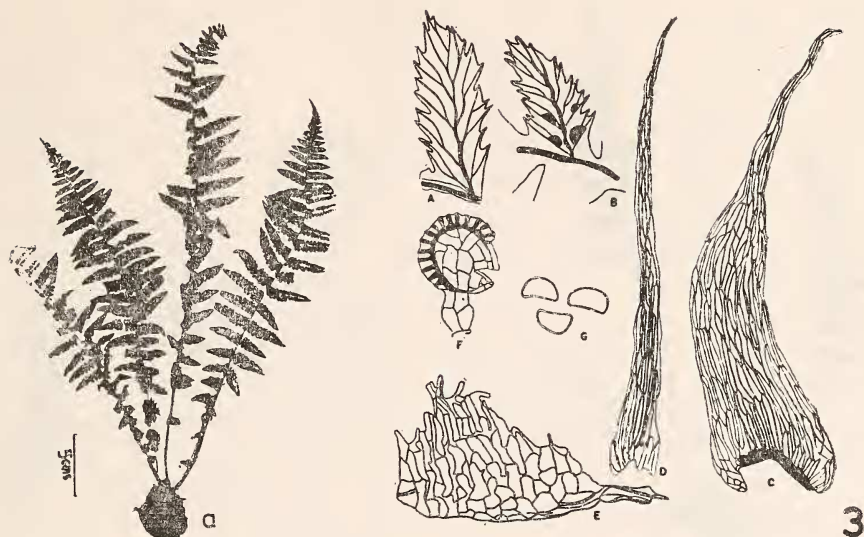


Fig. 3. *Athyrium attenuatum*. a. Plant. A. Pinna showing venation, $\times 2.0$; B. Pinna showing position of sori, $\times 2.0$; C. Rhizome scale, $\times 9.9$; D. Stipe scale, $\times 9.9$; E. Indusium, $\times 28.6$; F. Sporangium, $\times 44.7$; G. Spores, $\times 129.2$.

Fig. 4. *Athyrium falcatum*. a. Plant. A. Pinna showing venation, $\times 2.7$; B. Rhizome scale, $\times 7.2$; C. Stipe scale, $\times 7.2$; D. Rachis scale, $\times 7.2$; E. Hairs on pinnae, $\times 58.08$; F. Indusium, $\times 12.9$; G. Indusial cells, $\times 58.0$; H. Sporangia, $\times 58.0$; I. Spores, $\times 167.8$.

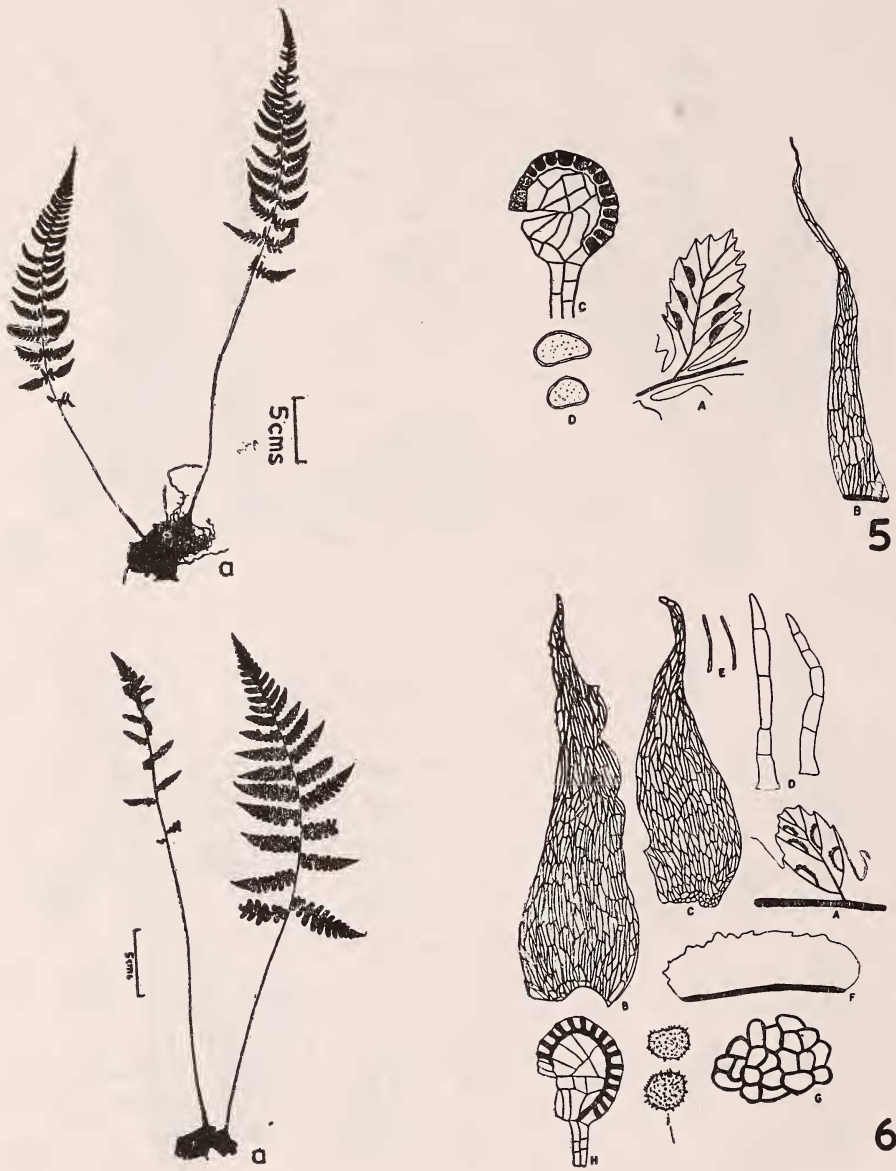


Fig. 5. *Athyrium drepanopterum*. a. Plant. A. Pinna showing venation, $\times 2.6$; B. Rhizome or base of stipe scale, $\times 7.1$; C. Sporangium, $\times 54.5$; D. Spores, $\times 157.56$.
Fig. 6. *Athyrium japonicum*. a. Plant. A. Pinna showing venation, $\times 2.2$; B. Rhizome scale, $\times 10.5$; C. Stipe scale, $\times 10.5$; D. Hairs of rachis and rachilets, $\times 47.6$; E. Hairs on surface, $\times 47.6$; F. Indusium, $\times 10.5$; G. Indusial cells, $\times 47.6$; H. Sporangium, $\times 47.6$; I. Spores, $\times 137.6$.

annular cells with thick transparent walls having dark brown luminae; spores hyaline, bilateral with smooth walled exine, non-perisporiate (Fig. 5).

This is a fern of low altitudes (1,200-1,500 m) growing on forest floor along water channels.

A. japonicum (Thunb.) Copel., Phil. Jour. Soc. Bot. 3C, 290, 1908.

Rhizome upto 3-4 mm thick, widely-creeping, scaly; scales 4-6 mm long, 1-2 mm wide at base, pale-brown, thin, lanceolate, hair pointed, sub-entire margined; fronds quite apart, long, herbaceous; stipe 10-20 cm long, scaly, scales similar to rhizome scales but smaller in size; lamina 10-24 × 6-14 cm, broadly lanceolate, bipinnatifid, rachis and rachilets more or less woolly with multicellular uniseriate hairs; pinnae alternate, 2-8 × 0.7-1.5 cm, subsessile, cut down quite to the mid rib into broad, falcate segments with obtuse apex and crenated margin; texture herbaceous, bright green in colour; venation pinnate, veins rarely forked; sori elongated nearer the midrib in 2 rows one on each side of the midrib, indusiate; indusium broad, thin, elongated, membranaceous with wavy margin, indusial cells polygonal with regular cell walls; spores light yellow to brown in colour with tuberculated exine (Fig. 6).

It prefers moist and shaded forest floor. Found at 1,950 m altitude around Nainital.

A. clarkei Bedd., Ferns Brit. India, Suppl., II, t. 360, 1876.

Rhizome 1 mm thick, ascending, scaly at apex; scales 6-8 mm long, 0.5-1.5 mm broad at base, dark-brown, linear-lanceolate, hair pointed uniseriate with smooth margin; fronds caespitose; stipes 11-20 cm long, scaly below, scales similar to rhizome scales but smaller in size; lamina 20-50 × 10-20 cm, lanceolate, bipinnate, rooting from a bud on the upper

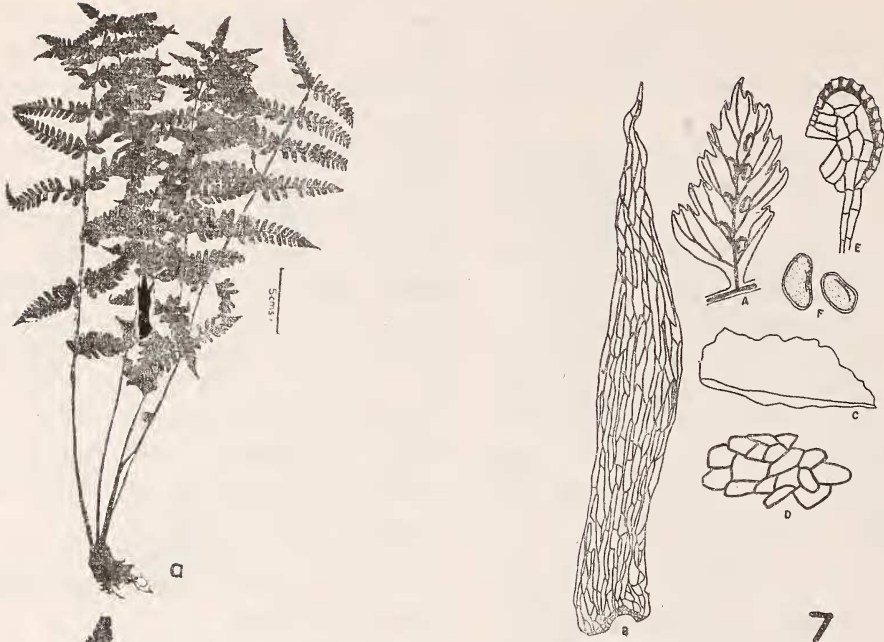
part of the rachis; pinnae deltoid-lanceolate, upto 9 × 2.2 cm; pinnules shortly stalked, acroscopic, basal one the largest, oblong, lobed up to half the way to the mid rib with serrated apex, primary rachis stramineous, secondary winged, setae present on upper surface along costae and constules; texture herbaceous, green; venation forked 1-2 times, single veinlet supplying to each tooth; sori short, oblong, curved, two rows one to each side of mid rib, indusiate; indusium reniform, thin, fugaceous with almost, wavy margin, indusial cells with smooth walls; sporangia having 14-15 annulus cells; spores light-yellowish-brown, reniform, non-perisporiate with a smooth exine (Fig. 7).

The species was found growing near Kilberi (2,000 m) on humus rich, densely shaded, and moist forest floor.

A. proliferum Moore, Gard. Chr., 778, 1866.

Rhizome 1-1.5 cm thick, ascending, scaly; scales 2-2.5 mm long, about 1 mm broad at base, lanceolate to oblong-lanceolate, hair pointed uniseriate, sub-entire margined; fronds closely tufted; stipe 14-17 cm long, hard, grooved, straw coloured with a dark-brown base, scaly, scales 4.5-5 mm long, about 1 mm broad at base, oblong-lanceolate, hair pointed; lamina 40-44 × 14-16 cm, lanceolate with pointed acuminate apex, tripinnatifid; pinnae 7-9 × 1.8-2.5 cm, lanceolate, 25-28 jugate, cut into 10-14 pairs of pinnules; each pinnule oblong, cut into 4-5 pairs of bifid lobes; texture coriaceous; venation simple, veins forked, almost reaching the margin, mid-vein wavy; sori linear, present along the superior veinlet, indusiate; indusium oblong with wavy margin, indusial cells squarish, irregularly margined with smooth cell walls; sporangia with 13-14 annulus cells; spores bilateral, thin-walled, hyaline, non-perisporiate (Fig. 8).

It prefers humus rich shaded forest floor



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Fig. 7. *Athyrium clarkei*. a. Plant. A. Pinna showing venation, $\times 2.5$; B. Rhizome or stipe scale, $\times 18.0$; C. Indusium, $\times 18.0$; D. Indusial cells, $\times 54.0$; E. Sporangium, $\times 54.0$; F. Spores, $\times 156.0$.

Fig. 8. *Athyrium proliferum*. a. Plant. A. Pinna showing venation, $\times 4.0$; B, C. Rhizome scales, $\times 19.0$; D. Stipe scale, $\times 11.2$; E. Indusium, $\times 19.0$; F. Indusial cells, $\times 248.0$; G. Sporangium, $\times 85.8$; H. Spores, $\times 248.0$.

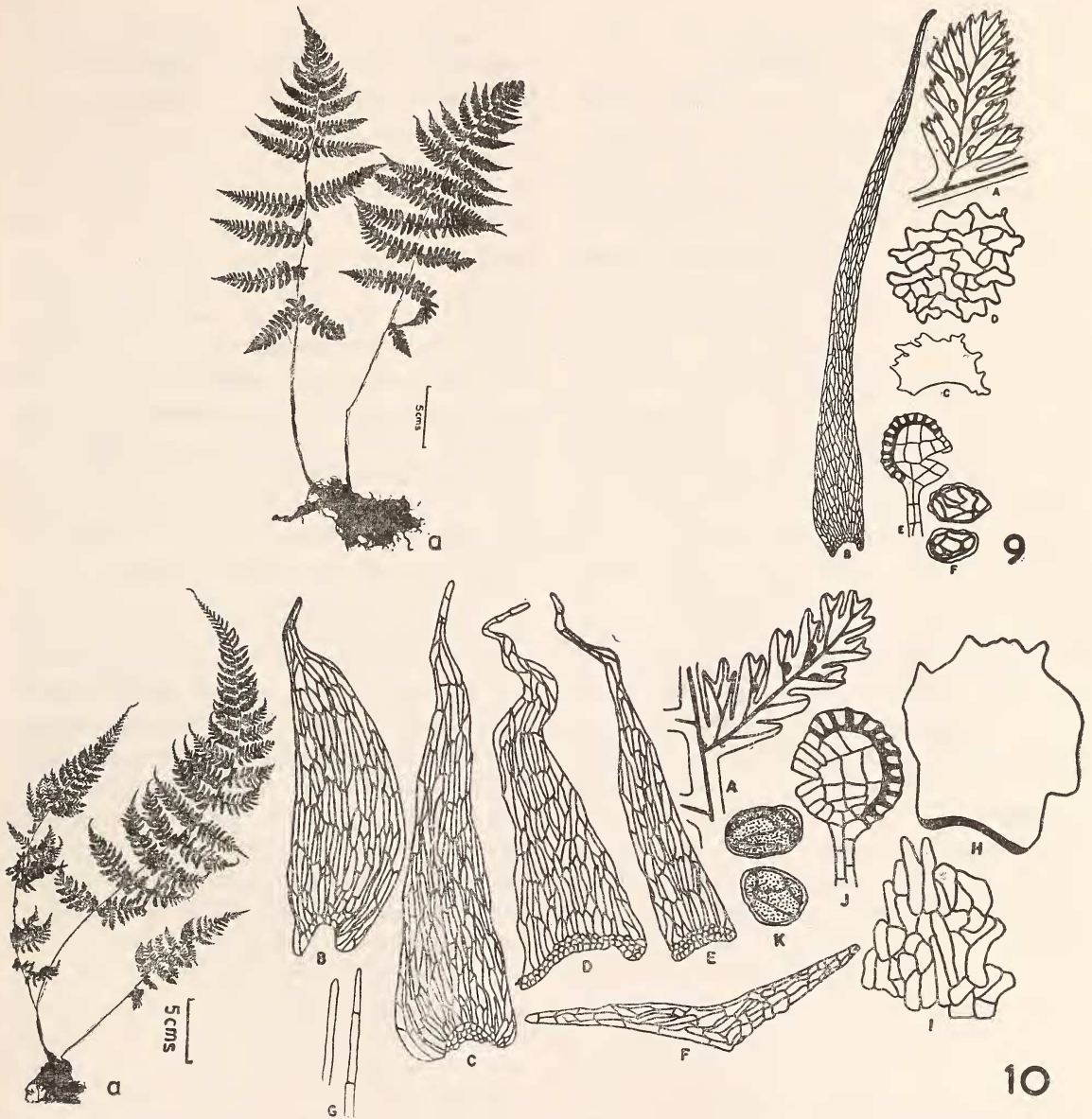


Fig. 9. *Athyrium schimperi*. a. Plant. A. Pinna showing venation, $\times 2.5$; B. Rhizome or stipe scale, $\times 12.0$; C. Indusium, $\times 12.0$; D. Indusial cells, $\times 54.0$; E. Sporangium, $\times 54.0$; F. Spores, $\times 156$.

Fig. 10. *Athyrium pectinatum*. a. Plant. A. Pinna showing venation, $\times 3.7$; B, C. Rhizome scales, $\times 18.0$; D. Stipe scale, $\times 18.0$; E. Rachis scale, $\times 18.0$; F. Spine on surface, $\times 18.0$; G. Hairs on both surfaces along veinlets, $\times 81.0$; H. Indusium, $\times 51.7$; I. Indusial cells, $\times 81.0$; J. Sporangium, $\times 81.0$; K. Spores, $\times 234.0$.

at an altitude of 1,950 m around Nainital.

A. schimperii Moug. ex Fee, Mem. Fougères, 5 (Gen. Fil.), 187, 1850-52.

Rhizome 0.4-0.6 mm thick, widely creeping, covered with dark-brown, linear-lanceolate, 3-4 mm long, upto 0.5-0.7 mm broad at base scales; fronds distant, yellowish to bright-green; stipes dark-brown at base, firm, erect, having a few scales near the base which are similar but smaller to rhizome scales; lamina variable, 26-30 × 14-18 cm, oblong-lanceolate, bipinnate; pinnae opposite below, alternate above, basal ones reduced; each pinna lanceolate acuminate, 7-8.5 × 1.5-2 cm; pinnules alternate, patent, having decurrent base, sessile, 1.5-2 × 0.8-1 cm, cut down half the way to the costa into 4-6 pairs of segments with serrate margin; texture herbaceous; venation generally forked; sori j-shaped or reniform at maturity, placed along the superior veinlets nearer to the costae, indusiate; indusium broad, firm with an irregularly lobed margin, indusial cells irregular with deeply lobed cell walls; sporangia with 13-14 celled annulus; spores dark-brown, perisporiate, perispore folded giving the appearance of reticulations (Fig. 9).

One of the commonest species of the area, growing in damp, shaded, and humus rich places. Met with near Land's end, snow-view, Lariakanta, and around the lake, between

1,800-2,400 m altitude.

A. pectinatum Presl, Tent Pterid., 98, 1836.

Rhizome 0.4-1 cm thick, widely creeping, branched, covered with yellowish-brown, thin, lanceolate, hair pointed, upto 2 mm long, 0.5-0.8 mm broad at base scales; fronds, tufted; stipes 5-17 cm long, straw coloured, fragile, scaly, scales 4.5-6 mm long, 0.5-1 mm broad at base, lanceolate, hair uniseriate, pointed; lamina 10-45 × 4-12 cm, lanceolate to subdeltoid with acuminate apex, finely dissected, 3-4 pinnatifid; primary pinnae 15-24 pairs, subsessile, sub-deltoid, acuminate, 4-7 × 2-4 cm. distantly placed, cut down into 7-10 pairs of 0.3-0.5 × 1-1.3 cm pinnules; pinnules further divided into ultimate segments with dentate margin; rachis greenish and grooved but rachilets pubescent with 1-3 celled uniseriate hairs on both surfaces, secondary rachis minutely spiny on upper side; texture subcoriaceous, firm; venation forked; sori small, present on superior veinlet, reniform, indusiate; indusium thin, membranaceous, more broad than long with wavy margin, indusial cells irregular elongated with smooth walls; sporangia with 13-16 celled annulus; spores dark brown, perisporiate, perispore loose and reticulately folded (Fig. 10).

This species inhabits open but rather moist situations along roadside. It is common around Bhowali (1,500 m).

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